Adjustments of High Plutonium-240 Solution Parameters

The parameters calculated for plutonium solutions containing plutonium isotopes higher than Pu-239 have been shown to be non-conservative (1). Under certain assumptions, it has been common practice to perform plutonium solution parameter calculations using only two isotopes (Pu-239 and Pu-240). The normal assumptions are that the Pu-239 represents the Pu-239 and Pu-241, and the Pu-240 represents the Pu-238, Pu-240, and Pu-242. The parameter studies made in III.A of ARH-600 used the two-isotope approach. Correlations reported in reference 1 with solutions of high exposure plutonium with weight percent composition of Pu-238 (0.2), Pu-239 (41.4), Pu-240 (42.9), Pu-241 (10.8), and Pu-242 (4.7) show that the two-isotope GAMTEC II - HFN calculation with the above assumption will actually be low by up to four percent in k-effective if the effect of Am-241 is included. The results for a number of computer codes and cross sections are shown in the table. (Since the effect of Am-241 was significant and the cross sections were not available in the original GAMTEC II set, the effect must be determined from the other calculations.) From these correlations it is apparent that the parameters calculated for plutonium with Pu-240 greater than 5 weight percent must be interpreted with caution. To safely use these parameters one of the following assumptions must be made:

1. The Pu-240 shown on the curves must be assumed to be only Pu-240, not both Pu-240 and Pu-242; and the Pu-239 must be assumed to represent Pu-239, Pu-241, Pu-242, and Pu-238 (if any).

2. If the Pu-240 shown on the curves is assumed to represent both Pu-240 and Pu-242 then the parameters shown on the curves should be decreased by an amount commensurate with the Δk shown on the graph, page III.A.1-5.

(1) R. D. Carter, "Criticality Parameter Calculation With High Burn-up Plutonium Solutions," ARH-SA-135, November 7, 1972.